AD-A189 772 APPLICATIONS OF OPTICAL COMPUTING TO PROBLEMS WITH SYMBOLIC COMPUTATIONS(U) BDM CORP MCLEAN VA B G KUSHNER 31 OCT 87 AFOSR-TR-87-1743 F49620-86-C-0030 1/1

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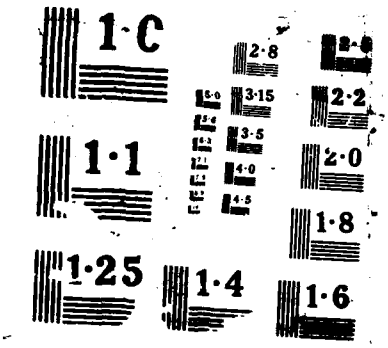
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In this quarterly report, we collaborated with the Optical Circuitry Cooperative in the Optical Sciences Center at the University of Arizona to experimentally demonstrate digital all-optical C&E circuits based on our original designs. The circuits use ZnS bistable optical devices in novel operational modes such as bidirectional and latching logic. These modes are central to the low complexity of the implementation. In addition, the experimental demonstration utilizes polarization multiplexing and filtering to reduce crosstalk, losses and feedback in the optical system. Also, we advanced the capabilities of optical interconnection networks that are generally useful in parallel processing and specifically useful in sorting.

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APPLICATIONS OF OPTICAL COMPUTING TO PROBLEMS WITH SYMBOLIC COMPUTATIONS

SEVENTH QUARTERLY R & D STATUS REPORT

October 31, 1987

Sponsored by
Defense Advanced Research Projects Agency (DoD);
ARPA Order No. 4952
Monitored by AFOSR Under Contract #F49620-86-C-0030

ARPA ORDER:	4952	CONTRACT No.:	F49620-86-C-0030
PROGRAM CODE:	5D10	PRINCIPAL INVESTIGATOR:	Dr. Brian G. Kushner
CONTRACTOR:	The BDM Corp.	PROGRAM MANAGER:	Dr. Brian G. Kushner (703) 848-7903
EFFECTIVE DATE OF CONTRACT:		JANUARY 15, 1986	
CONTRACT EXPIRATION DATE:		DECEMBER 31, 1987	
AMOUNT OF CONTRACT DOLLARS:		$346,624	

1. **Description of progress during the reporting period, supported by reasons for any change in approach reported previously.**

During previous quarters of research, we identified the compare-and-exchange operation (C&E) as an important computational primitive for switching networks in symbolic computing applications. The C&E module routes two information channels based on the relative magnitude of the information that they contain. This active function combined with passive interconnection networks realizes sorting networks that have low delay and are pipelinable for high-throughput. Because of the limited size and bandwidth of electronic interconnection networks, in certain applications the number of channels and/or their individual bandwidth is high enough to justify an optical implementation.

In previous work, we proposed optical implementations of the C&E operation using various technologies. In this quarter, we collaborated with the Optical Circuitry Cooperative in the Optical Sciences Center at the University of Arizona to experimentally demonstrate digital all-optical C&E circuits based on our original designs. [1] The circuits use ZnS bistable optical devices in novel operational modes such as bidirectional and latching logic. These modes are central to the low complexity of the implementation. In addition, the experimental demonstration utilizes polarization multiplexing and filtering to reduce crosstalk, losses and feedback in the optical system.

Also, during this quarter, we advanced the capabilities of optical interconnection networks that are generally useful in parallel processing and specifically useful for sorting. The passive interconnects that must be combined with the C&E modules for sorting networks are global and space-variant. It is precisely these properties that limit the capabilities of electronic sorting networks. An interconnection network that performs the permutations necessary for sorting networks is the perfect shuffle. [2] The perfect shuffle

is analogous to shuffling a deck of cards without error when the number of cards is a power of 2. An optical implementation of the perfect shuffle was demonstrated that is capable of shuffling the rows or columns of a matrix using classical optical devices. [3] Since the optical devices are passive, this system is capable of very high bandwidth communication, but the maximum number of channels that can be shuffled together is limited by the size of the matrix along one dimension (N)--the other spatial dimension is available to encode the information in the channels or to encode other channels that must be shuffled together separately.

Our contribution was to consider shuffling as a 2-D operation on a 2-D representation of a very long 1-D list of channels. [4] By transforming the 1-D shuffling operations into 2-D operations in a manner consistent with the 1- to 2-D list representation transformation, we were able to design optical systems that are capable of shuffling together channels that are recorded along the rows and columns of the matrix. Thus, the size of the perfect shuffle kernel has been increased from N to N^2 without sacrificing the bandwidth per channel. Combined with high-performance optical C&E modules, the folded perfect shuffle optical processor will be capable of implementing low-delay, high throughput sorting networks for many parallel channels.

1. L. Zhang, R. Jin, C. W. Stirk, G. Khitrova, R. A. Athale, H. M. Gibbs, H. M. Chou, R. W. Sprague and H. A. Macleod, All Optical Compare-and-Exchange Switches, Submitted to IEEE Journal on Selected Areas in Communication, Oct. 15, 1987

2. Stone, H. S., Parallel Processing with the Perfect Shuffle, IEEE Trans. Comput. C-20(2), 153-161 (1971).

3. Lohmann, A., Stork, W. and Stucke, G., Optical Implementation of the Perfect Shuffle, Proc. OSA Topical Meeting on Optical Computing, Lake Tahoe, NV, paper WA3 (1985).

4. C. W. Stirk, R. A. Athale and M. W. Haney, The Folded Perfect Shuffle Optical Processor, Accepted for Publication in Applied Optics, Sept. 87.

2. **Description of any major items of experimental or special equipment purchased or constructed during the reporting period.**

No such items were purchased or constructed during the reporting period.

3. **Notification of any change in key personnel associated with the contract during the reporting period.**

No changes in key personnel were made during the reporting period.

4. **Summary of substantive information derived from noteworthy trips, meetings, visits, and scientific papers during the reporting period.**

No conference trips or other meetings took place during this reporting period.

5. **Summary of any problems or areas of concern on which Government assistance or guidance is desired.**

No such problems or areas exist.

6. **Statement relative to any anticipated deviation in the contractor's planned effort to achieve the objectives of the contract.**

No deviations are anticipated.

7. **Fiscal status.**

(a)	Amount currently provided for the contract:	$ 346,624
(b)	Expenditures and commitments to date (8/31/87):	341,621
(c)	Estimated funds required to complete the work:	5,003
(d)	Estimated date of completion of work:	12/31/87

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